(NASA-IM-X-70333) PHOTOGRAPHY FROM SPACE TO HELP SOLVE PROBLEMS ON EARTH (NASA) 19 p HC $4.00 CSCL 14B

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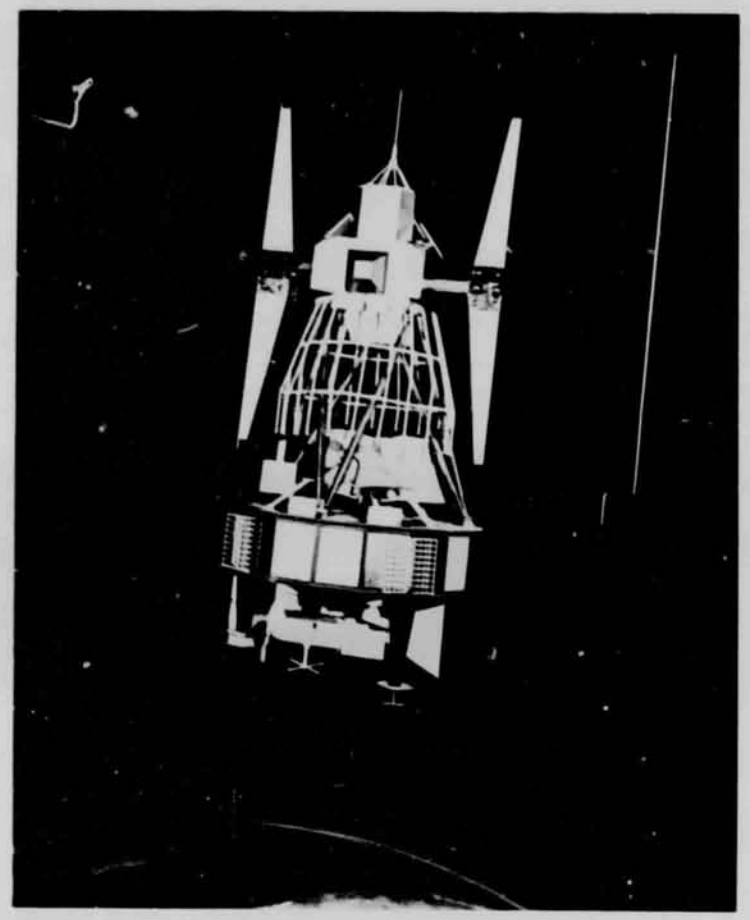
PHOTOGRAPHY FROM SPACE TO HELP SOLVE PROBLEMS ON EARTH



Rediscovering The Earth Through Space Technology

Energy crisis ... pollution ... diminishing land, mineral, water resources ... population growth ... overpowering agriculture production ... urban decay ... each of these phrases, and others like them, are now subjects of heated debate. They are the problems of modern society. And make no mistake about this, they are real, not imagined problems.

There are no simple answers; no simple solutions to these problems. They will be solved by careful study. By knowledge and action harnessed together in a concerted national effort to protect and enhance our total environment.

In March, 1973, scientists and engineers using ERTS photos in their search for solutions to problems of earth delivered papers on early results of their activities. Here are a few exerpts of what they had to say.

In recent years, as conventional tools and techniques faltered in their struggle with terrestrial problems, space technology has stepped forth with new ideas ... new ways to solve problems.

Earth satellites have proven to be invaluable tools for man as weather monitors, communications relay devices and platforms for observing "Spaceship Earth."

The most recent of these observation satellites is the Earth Resources Technology Satellite (ERTS). Launched on July 23, 1972, ERTS-1 takes special "photos" of the earth from a 560 mile high, near polar orbit. The nature of the orbit allows the spacecraft to photograph nearly the entire globe once every 18 days ... then repeat the coverage ... allowing scientists to observe changes on the earth's surface almost as they occur.

Agricultural fields, surface water, types of land forms, patterns of urban development and other changes in the earth's surface from natural or man-made causes are now observed on a regular and objective basis.

ERTS carries two remote sensing systems, a Multi-Spectral Scanner (MSS) and Return Beam Vidicon (RBV) camera system, that record photographic images in visible and invisible bands of the light spectrum. The images are electronically transmitted to the NASA Data Processing Facility (NDPF), at the Goddard Space Flight Center, Greenbelt, Maryland, where the data are reconstructed to produce pictures in black and white or combined to produce false color composites.

ERTS-1 also carries a Data Collection System (DCS) that acquires water quality, rainfall, snow depth and seismic activity information from remotely located sites in North America and transmits the data back to Goddard.

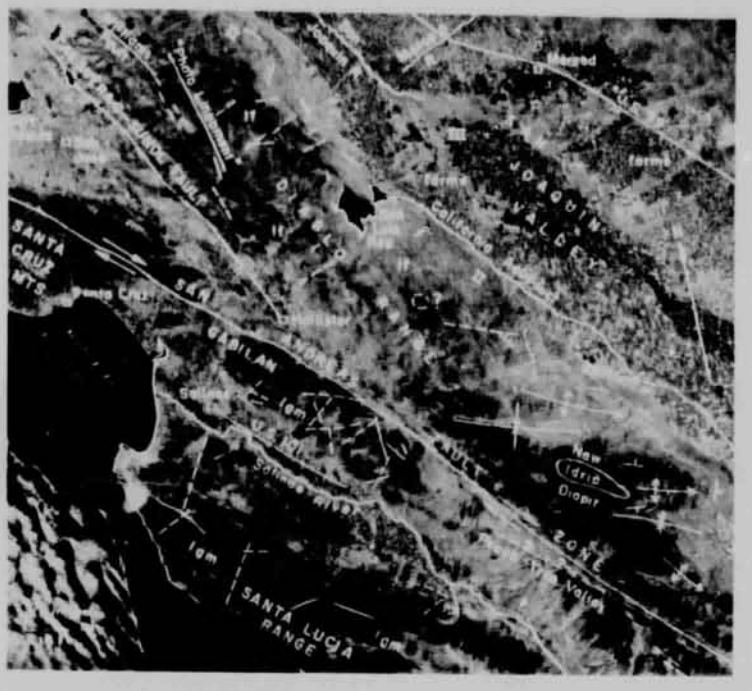
Each ERTS picture covers an area of over 13,000 square miles. High contrast features no larger than 30 meters have been resolved in ERTS pictures.

The ERTS Operations Control Center, the NDPF and a ground receiving station are located at Goddard. Other U.S. ground stations are in Alaska and California. A Canadian ground station is located in Saskatchewan.

The ERTS project is managed by Goddard for NASA's Office of Applications. Prime contractor for the spacecraft, the NDPF and the DCS platforms is the General Electric Company, Valley Forge, Pa. Other prime contractors are Hughes Aircraft, Culver City, Ca., for the MSS; and RCA, Princeton, N.J., for the RBV system and wideband video tape recorders.

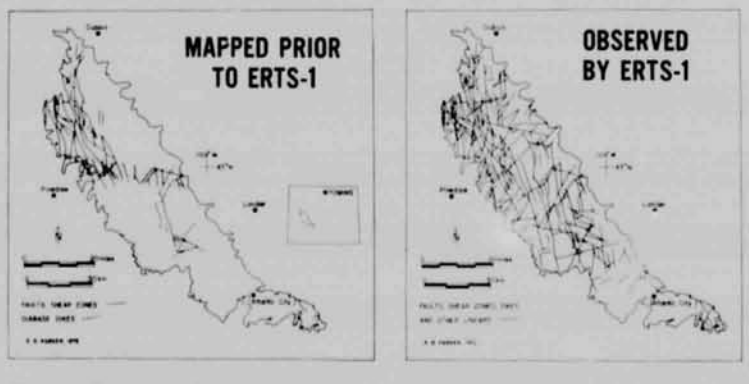
Federal agencies participating with NASA on the ERTS program are the Departments of Agriculture, Commerce, and Interior, the Corps of Engineers, and the Environmental Protection Agency.

Mineral



This scene of the Monterey, California area provides an example for making accurate maps of geologic structure mainly on the basis of the numerous linear features displayed in the ERTS image. Such features often relate to geological faults which reveal the dynamic processes taking place in the earth's crust and are indicative of earthquake activity. The San Andreas and Calaveras-Sunal faults are prominently shown in this image, as are numerous other faults not previously identified.

NOTE: False color ERTS imagery shows healthy crops, trees and other green plants in shades of red. Areas with sparse vegetation appear as pink and barren lands as light gray. Cities and industrial areas register generally as dark gray. Water, depending on the amount of sediment, appears as varying shades of blue.



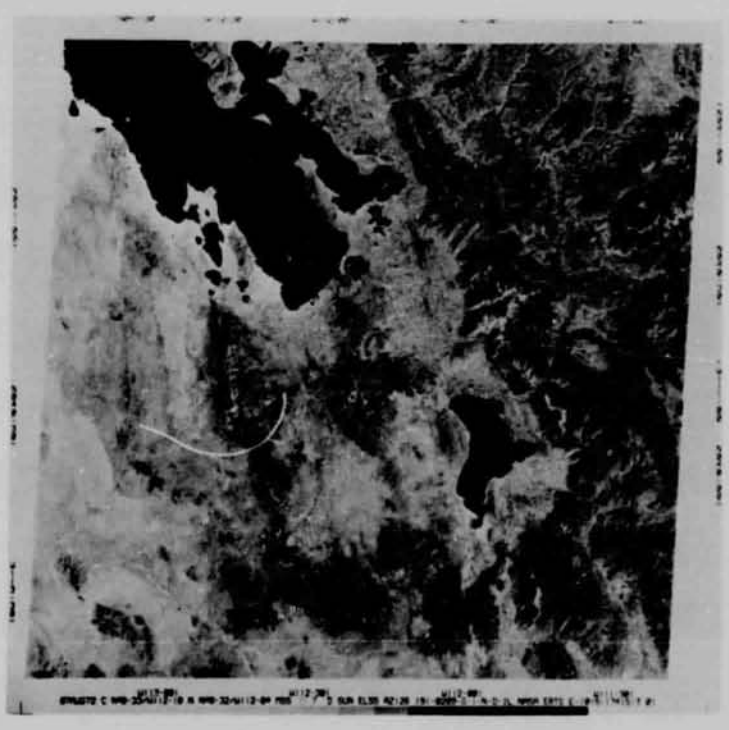
These before and after sketches of the geological structure in the Wind River region of Wyoming emphasize the amount of geological information which has become available from ERTS that can be applied to mineral explorations. Knowledge of the major geological fractures in this rather inaccessible region has increased tenfold since ERTS pictures have been made.

Land Resources

WILLIAM FISCHER
U.S. Geological Survey
Department of the Interior

"The results of the (ERTS) investigation are relevant to three national problems: the need to accelerate the identification of minable minerals, the need to accelerate the finding and development of petroleum, and the need to preserve the environment."

"The initial objectives of the ERTS geological study of Alaska were to improve geologic knowledge and theories as they relate to mineral resource potential and secondly, to improve medium and small scale geologic mapping and extend geologic mapping into unknown areas. *These objectives have been accomplished."*



A variety of mineral and land resources, plus water resources, are evident in this ERTS image of the Salt Lake City, Utah area. The world's largest open pit copper mine is in photo center. The Great Salt Lake is in the upper left. The mountains of the region will be surveyed for mineral deposits through remote sensing and surface exploration. Reservoirs in the mountains provide water for land irrigation in the agricultural belts of the region.

Cook Inlet in Alaska will be a major commercial region in Alaska's economic development. Off-shore oil production, marine terminal facilities, and fisheries will require continual monitoring to insure that the area is not injured ecologically. ERTS provides water circulation patterns, pollutant trajectories and water boundary information.

Several raging forest fires (arrow A) are dramatically shown in this image of the north central portion of Alaska. Over two hundred square miles of timber had been destroyed when this ERTS image was taken. Previous forest fire burns can also be seen (arrow B). The remaining red is heavily timbered land in the mineral-rich state. White regions in the lower portion of the image are clouds.

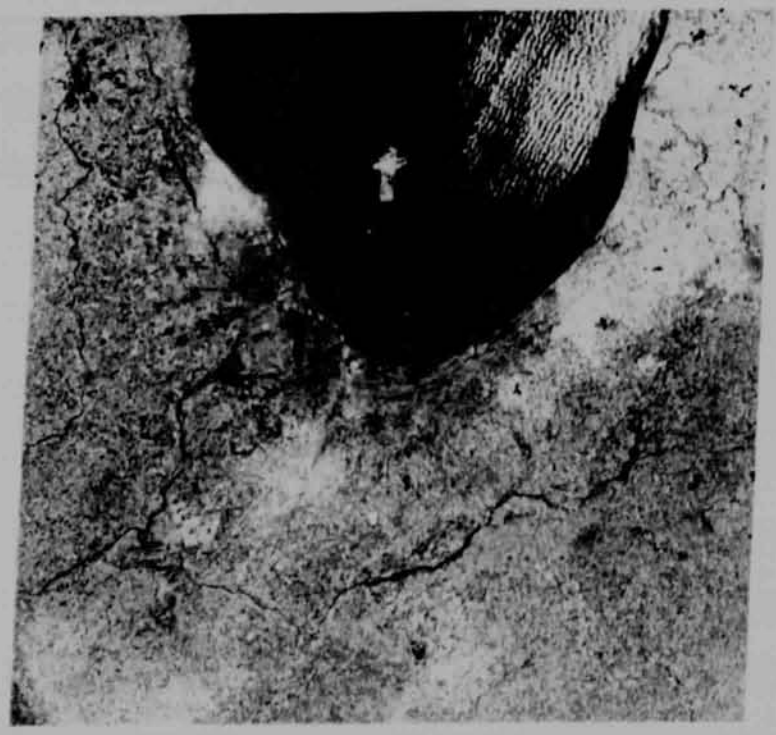
Environment

JOHN M. MILLER
University of Alaska
Fairbanks, Alaska

"... One of the most crucial problems in Alaska today is a great environmental knowledge gap. This gap seriously impedes planning and adversely affects decision-making processes at a very critical time in the development of Alaska's economic and social regime."

"Alaska is so vast, and the arctic environment is so varied, that this environmental knowledge gap will not be bridged quickly by conventional means, or with normal dollar resources. This is why the ERTS program, which has demonstrated its capability for economical, large-scale surveys affords a unique opportunity to narrow the knowledge gap."

"The applications of ERTS data are playing an extremely vital and timely role in the planning for the imminent, and we hope, orderly development of Alaska."



Probable inadvertent weather modification in the form of snowfall is shown in this ERTS image of the southern shore of Lake Michigan. Smoke plumes from heavy industry along the shore carried particulate matter aloft apparently causing snow to form in the cloud bank over Lake Michigan. A significant amount of silt can also be seen along the shoreline. This may be the result of pollutants or sediments introduced into the lake by topsoil erosion, urbanization or construction activities.

LAND USE MAP OF SAN JOAQUIN COUNTY

17 DISTINCT LAND USES CAN BE IDENTIFIED FROM THIS ERTS IMAGE

EXAMPLES

1. Urban and commercially developed areas
2. Rangeland
5. Irrigated pasture, dry crops
11. Orchards and vineyards
16. Crops, corn, alfalfa, sugarbeets

Agricultural patterns in the Sacramento and San Joaquin Valleys of California are vividly displayed in this portion of an ERTS image. Color tones which are caused by different brightnesses of terrain, water and various types of vegetation can be related to land use classes. Seventeen such distinct classes are delineated and accurately mapped for San Joaquin County.

The accuracy of the mapping, the number of classes which can be identified, and the speed with which maps can be produced from ERTS pictures are much greater than conventional census methods. Yet the cost of deriving this information from satellite photos is only a fraction of the cost of conventional surveys.

Land Use

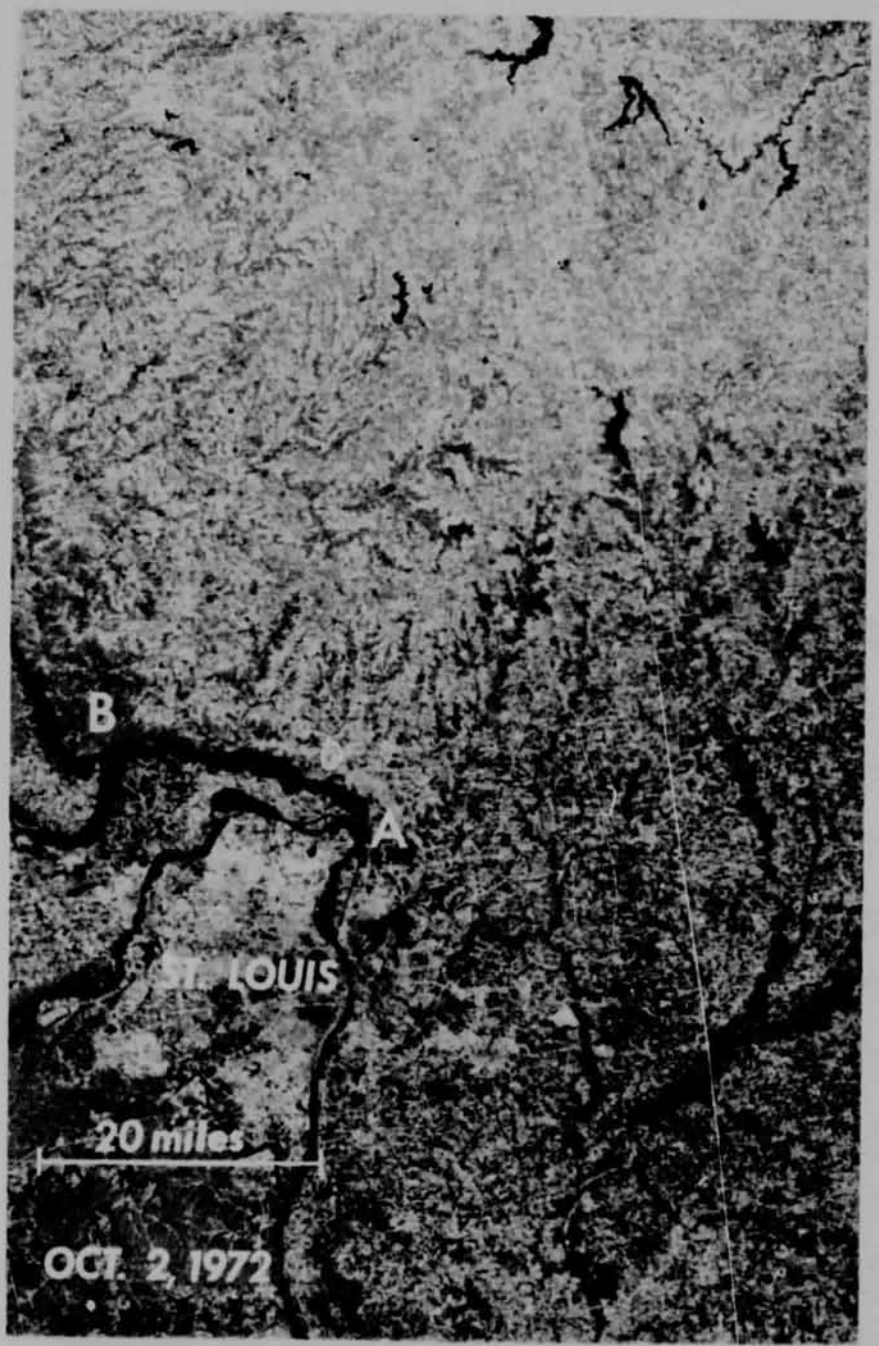
DR. DAVID LINDGREN
Dartmouth College
Hanover, New Hampshire

"Also ..... ERTS is cost effective. By the most conservative estimates, land use mapping by satellite is cheaper by more than an order of magnitude over land use mapping from conventional, medium altitude aerial photography."

"... It is for the first time economically possible to acquire land-use data quickly and efficiently over large areas. This is an indispensable capacity if we are ever to control urban growth and protect our land resources."

"... The value of ERTS to the countries of the developing world is inestimable. In some parts of these nations the ERTS photos themselves are better than any existing map."

This scene of the New York City/Philadelphia region is a particularly good example that demonstrates how information extracted from ERTS images can be applied to land use management, urban planning and environmental planning. The metropolitan areas of New York City (1), suburban Long Island (2), Trenton, New Jersey (3), Allentown/Behtlehem, Pennsylvania (5) and Reading Pennsylvania (6) can be readily classified by color variations in the image. Highways and railroads forming major transportation networks such as the New Jersey Turnpike (7) are visible. White areas indicate either construction activities, barren or dry fields, or the sandy beaches of the New Jersey barrier islands. The forested Appalachian mountains are shown as bright red.



This is the St. Louis, Missouri area as seen by ERTS-1. In the photo taken on October 2, 1972, normal river level conditions are shown. The Missouri River joins the Mississippi River at point A, and further upstream the confluence of the Illinois and Mississippi Rivers is noted by point B.

Water Resources

DR. VINCENT SALOMONSON
NASA Goddard Space Flight Center
Greenbelt, Maryland

"... The fields of water resources and hydrology have been reaping benefits from the application of technology from space since the launch of TIROS 1 on April 1, 1960."

"With ERTS one can say that a very clearly valuable and beneficial observation tool is now available to the hydrological and water resources management community."

"... Our principal challenge lies in conserving the quality and quantity of our waters so that they can be used to maximum advantage in the sustaining of our lives and the life upon which we depend."

The above photo was taken over the same area on March 31, 1973. It clearly shows land under water (points C) as a result of the flooding. At the time this image was taken, the Mississippi River at St. Louis was at a stage of 38 feet and rising. By late April the water crested at 43.1 feet, highest in history. Approximately 300,000 acres of land had been flooded in the St. Louis area at the time this photograph was taken.

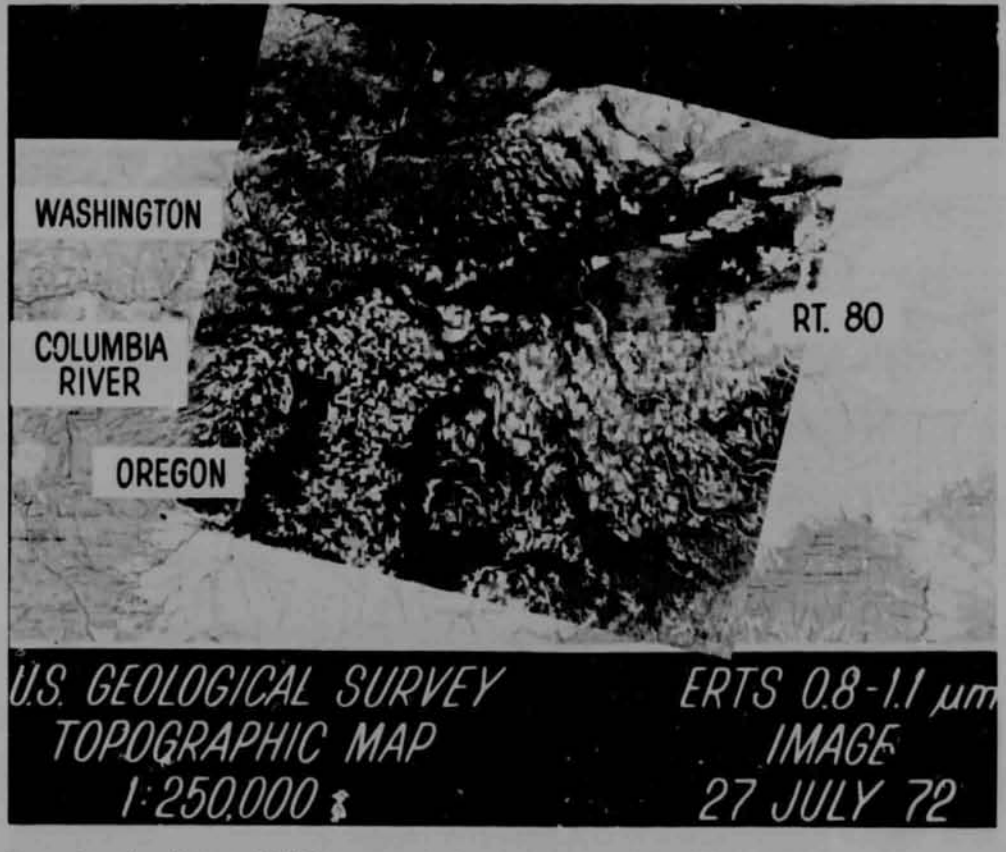
The overlay of the Washington, D.C.-Baltimore, Maryland area indicates the adaptability of ERTS imagery for map making and updating existing maps on a regular basis. ERTS pictures have already been used as the principal source of information to produce accurate maps of remote areas of the world. Many of the emerging nations in Africa and Asia will save countless monies by using ERTS imagery which is available to any nation at nominal cost.

Mapping and Charting

ALDEN P. COLVOCORESSES
U.S. Geological Survey
Department of the Interior

"From the mapping viewpoint, ERTS has exceeded expectations. For the first time in history mapmakers have now the source material from which image maps of small scale can be produced efficiently and accurately."

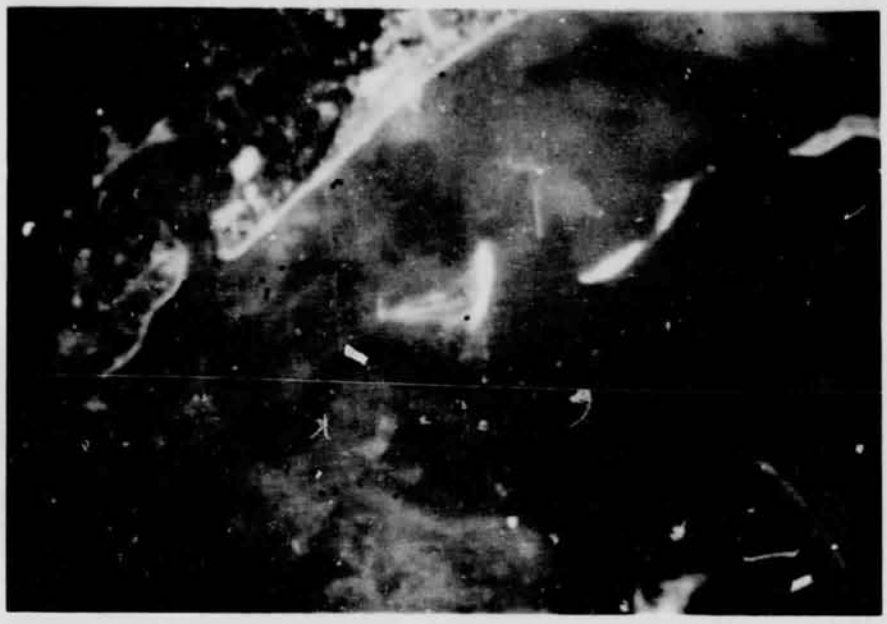
"... Image quality permits meaningful products to be produced up to at least 1:250,000. However, ... there is evidence that by applying corrections based on ground control, geometric accuracy can be improved without sacrificing quality."



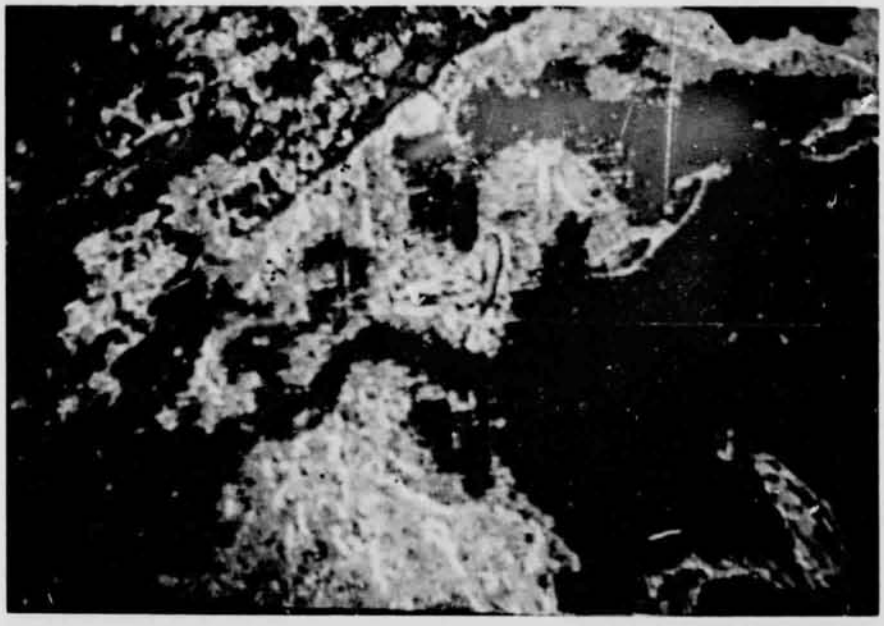
The scale and resolution of ERTS imagery make it an extremely useful tool for thematic mapping. Tonal variations can be measured and related to mapping of population concentrations, agriculture patterns, transportation systems, geological structure and hydrological features. Enlargements of ERTS images can be made up to scales of 1:250,000 without loss of definition.

This is illustrated by this scene of the Columbia River and the adjoining states of Washington and Oregon. The ERTS image was photographically enlarged to a scale of 1:250,000 and overlayed on a map. With ERTS imagery, cartographic changes can be made accurately and frequently.

Marine Resources /



While results are preliminary, ERTS imagery appears to contain information relavent to the location of fish. The small black dots indicate menhaden fish schools in a portion of Mississippi Sound along the Gulf of Mexico. Low flying aircraft spotted the fish school locations at the same time ERTS-1 recorded the picture during a pass over the region.



Computer enhancement reveals subtle brightness changes in the water. The color enhancement technique indicates that the menhaden fish schools were located in or adjacent to water that registers as yellow. The color variations indicate difference water densities. The data demonstrates the feasibility of using satellite-borne remote sensors to predict fish distribution.

Oceanography

GIFFORD EWING
Woods Hole Oceanographic Institution
Cape Cod, Massachusetts

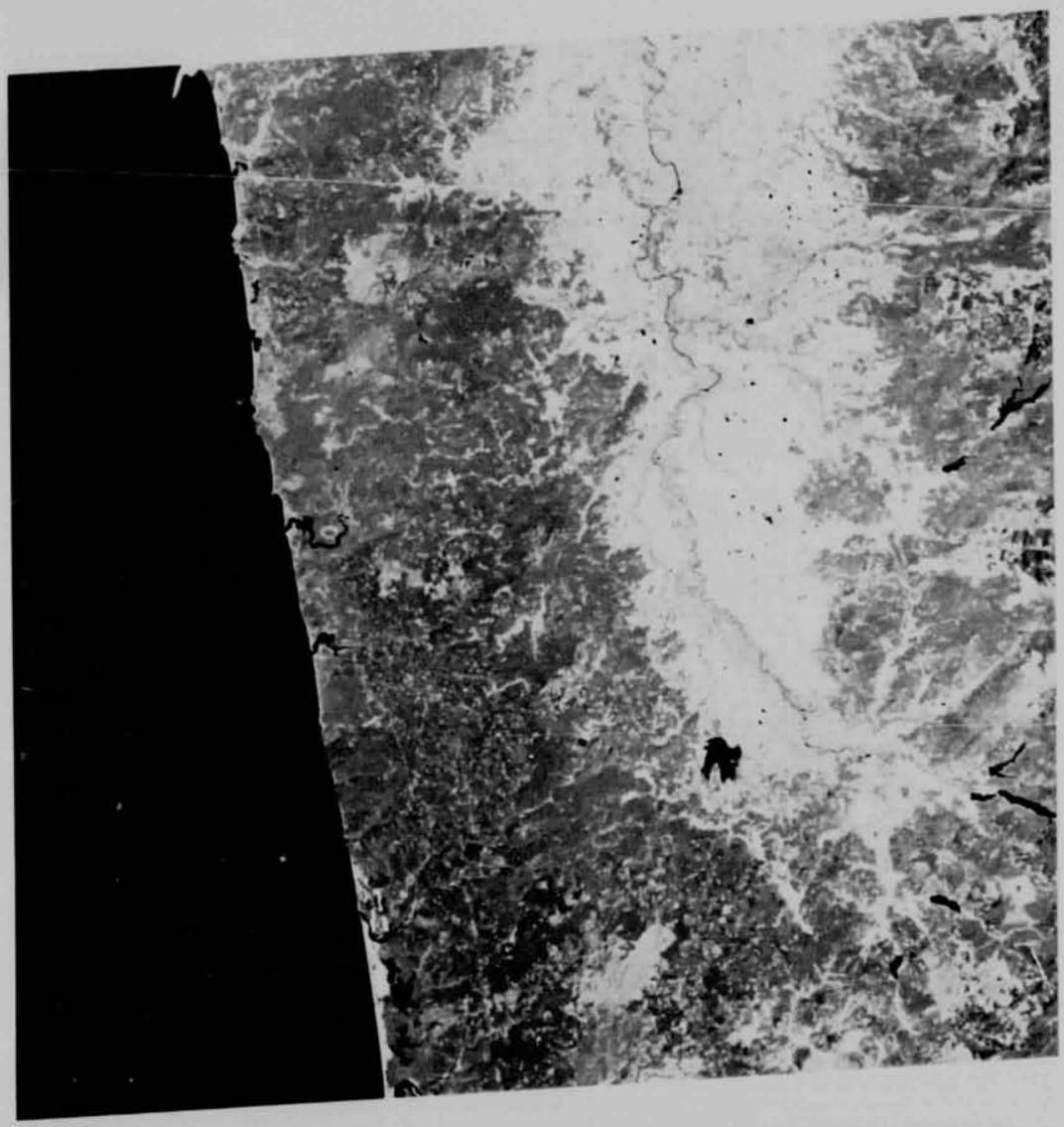
"... Information (from oceanographic ships) has been discontinuous in space and in time. Now that has gone out the window, at least with respect to things that happen in the upper parts of the sea, with the advent of the satellite."

"I cannot escape the conclusion that oceanography is going to be altogether different from now on, because we can now look at the globe -- we can circumnavigate the globe in something like 90 minutes -- and we can repeat this as often as we wish."

"It is a spectacular example of the ability of the satellite ... to go into a very inaccessible area, such as the Northwest Passage, and bring back news on ice pack formation and age!"

Nearly inaccessible areas, such as this portion of the Northwest Passage in Canada, can be easily viewed by ERTS. The icebergs measure miles on a side. The largest iceberg, at bottom center, is 10 by 20 miles. The islands reveal no vegetation or soil coverage.

Agriculture / Forestry /



The coast of Oregon is shown from Winchester Bay to Cape Lookout. The Willamette Valley is identified by the checkerboard fields indicating a wide variety of crops in this extensive farming region. Analysis of the varying shades of red provides information on the nature of the agricultural crops.

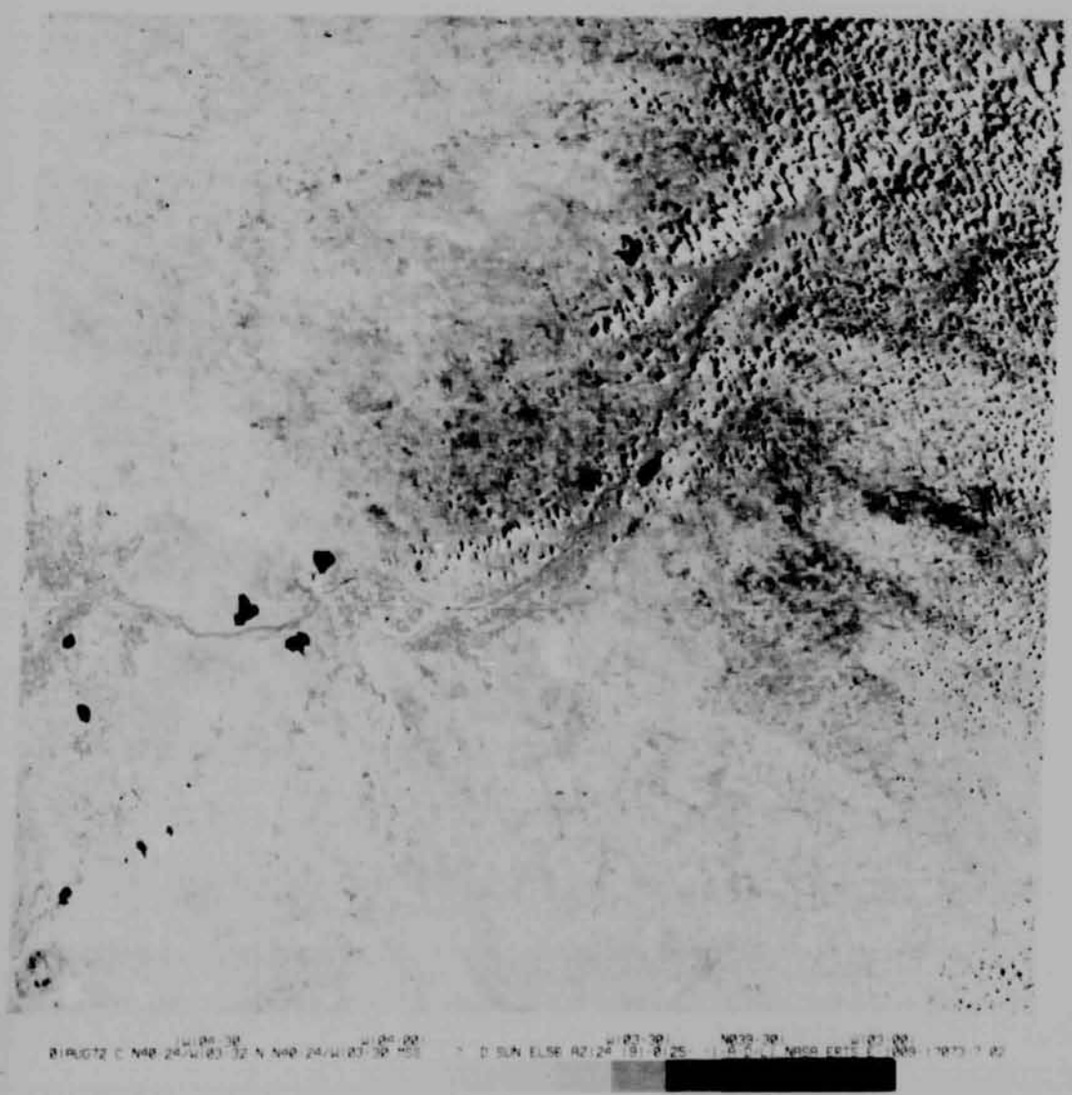
Timber cuts and reforested areas are easily plotted in the heavily forested mountains. Wood, the prime source of paper products and home construction materials requires effective management. ERTS imagery provides a method of inventory timber areas on a regular basis.

Range Resources

CHARLES E. POULTON
Oregon State University
Corvallis Oregon

"... One of the greatest benefits to agriculture, range resources and forestry is the repetitive coverage of ERTS. In some disciplines repetitive coverage is not important, but in agriculture, forestry and range resources ***it's critical ... we can't live without it!***"

"ERTS provides a perspective and a view of the interrelationships between problems and between man and his environment that we've never had before."



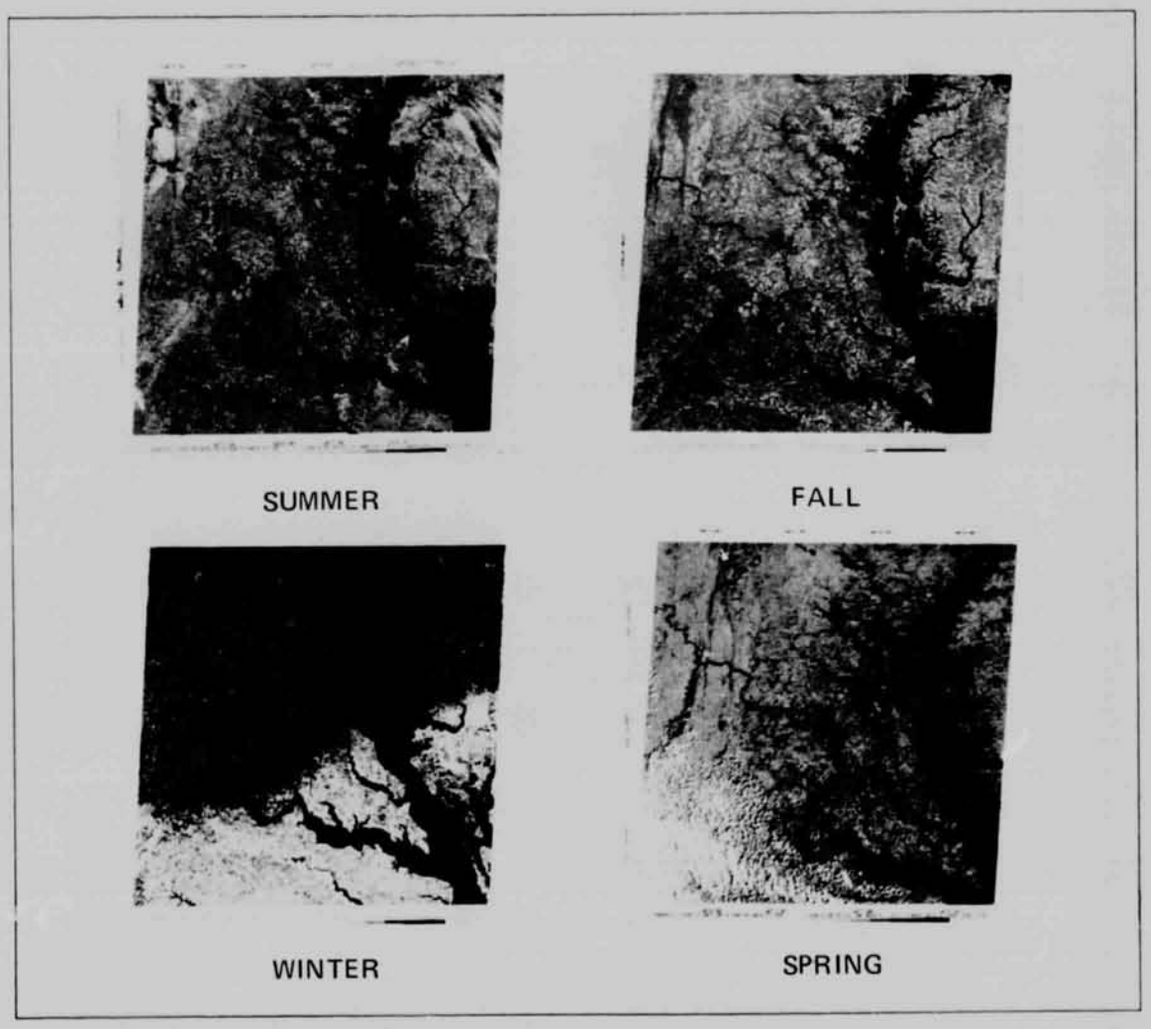
Concentrated agriculture, extensive rangeland and the use of underground water sources are shown in this ERTS image of the northeastern area of Colorado. The South Platte River, numerous reservoirs and underground wells provide the water necessary for agriculture. Circular water spray patterns are evident in the heavily vegetated areas shown in red.

Viewing The Changing Face Of Earth

Monitoring of ecological change ... rapid evaluation of agricultural production ... proper management of urban land areas ... prudent use of existing and newly discovered resources ... all can be done from space.

As man and nature change the face of the earth, observation satellites provide a method to view these changes on a regular and objective basis.

ERTS-1 is the "pathfinder" in the use of space technology to help solve "down-to-earth" problems.



These scenes of the Washington, D.C.-Baltimore area show the changes that occurred over a one year period as observed by ERTS-1.

"Time is a sort of river of passing events; no sooner is a thing brought to sight than it is swept by and another takes its place..."

Marcus Aurelius 121–180 AD

Mosaics Tell A Larger Story

The highly accurate ERTS image allows large mosaics to be produced to provide synoptic views of huge land areas, hundreds of thousands of square miles in size.

From New York City to Norfolk, Virginia ERTS images view the Middle Atlantic States. Six separate images were combined to make the picture.